VIRTUAL SIMULATION EXPERIMENTS IN A SIX DOF MOTION ENVIRONMENT FOR THE EVALUATION OF C2 ON THE MOVE AND HUMAN-ROBOT INTERFACES

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The US Army Tank Automotive Research Development and Engineering Center (TARDEC), Army Research Laboratory (ARL), and Corps of Engineers Engineering Research and Development Center (ERDC) are working towards the development of virtual simulation technologies and their employment towards experimentation associated with command and control on the move and the control of unmanned ground vehicles. The emphasis of the effort involves the intrinsic mobility and vibratory characteristics of the ground platform and the interface between the platform and the human operator. The planned experiments will be executed in an immersive environment specially constructed with audio, visual, and motion sensory stimuli within a Future Combat Systems (FCS) crew station in order to present the greatest degree of presence to the human operator.

The work is being performed under the auspices of the High Fidelity Ground Platform and Terramechanics Modeling Science and Technology Objective (HGTM STO), which involves the development of real-time simulation technologies for high-resolution ground vehicle and terrain models and their employment in studies investigating methods of mitigating the effects of motion on soldier performance. The work is facilitated through the use of high-performance computing facilities, reconfigurable six degree of freedom motion simulators capable of recreating harsh off-road motion profiles, and reconfigurable crew stations with relevant FCS display devices, operator controls, and software for situational awareness and command and control.

The experimentation plan addresses two issues directly of concern to the US Army's FCS: On-the-move operations and size and weight constraints of crew station design. The first issue addresses problems related to operations that occur in a dynamic environment that previously occurred in either a stationary environment or at operating tempos significantly less than what is expected of FCS. The second issue directly impacts the design of the crew station in terms of display and control devices.

Experiments of this type are usually examined through the use of training simulators or existing systems that perform as surrogates for future systems. Training simulators are constrained by the idea that they will generally be expected to be employed as embedded packages on the real systems and, as such, are limited in the amount of computational hardware and resources that may be utilized. This creates the need to trade the amount of resolution available within the modeled environment, resulting in vehicle models that are not sufficient for design-level trade studies. Existing systems that serve as a surrogate for future conceptual systems are constrained in the sense that a surrogate system is, by definition, not the future system. In addition, surrogate systems require a real world environment (typically a proving ground or operational test site) to operate in possibly adding additional constraining factors such as available locations and operating environments. Also, the possibility of performing trade studies on the design of the platform itself is lost due to the employment of already existing hardware.

The goal of the HGTM STO is to provide models of FCS ground platform conceptual chassis & suspension designs – and mock-ups of crew station designs - with a resolution and reconfigurability that is sufficient for an engineer to perform design trade studies (and for the government to provide an objective evaluation of the conceptual design) within a controlled laboratory environment. In addition, these studies can be conducted using a battlefield situation generated by the US Army's One Semi-Automated Forces (OneSAF) and could be combined with the capabilities provided by the Army's distributed simulation efforts such as the Research Development and Engineering Command (RDECOM) Modeling Architecture for Technology Research and Experimentation (MATREX), the Development Test Center (DTC) Synthetic Environments Integration Testbed (SEIT), or the TRADOC Battle Lab Collaborative Simulation Environment (BLCSE).

Specific experiments already executed or planned for the remainder of the HGTM STO include:

(1) Occupant reach and tactile operation in a dynamic motion environment
(2) Influence of suspension design (active, semi-active, passive) on driver and/or commander performance
(3) Influence of display type (flat panel versus head mounted display) on driver and/or commander performance
(4) Influence of display device field of view on driver performance

Report Documentation Page

Form Approved
OMB No. 0704-0188

1. REPORT DATE	2. REPORT TYPE	3. DATES COVERED
00 DEC 2004	**N/A**	-

4. TITLE AND SUBTITLE	
Virtual Simulation Experiments In A Six Dof Motion Environment For The Evaluation Of C2 On The Move And Human-Robot Interfaces	5a. CONTRACT NUMBER
	5b. GRANT NUMBER
	5c. PROGRAM ELEMENT NUMBER
6. AUTHOR(S)	5d. PROJECT NUMBER
	5e. TASK NUMBER
	5f. WORK UNIT NUMBER
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) **US Army RDECOM Tank Automotive Research Development and Engineering Center (TARDEC) Ground Vehicle Simulation Laboratory (GVSL) Warren, MI 48397**	8. PERFORMING ORGANIZATION REPORT NUMBER
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)	10. SPONSOR/MONITOR’S ACRONYM(S)
	11. SPONSOR/MONITOR’S REPORT NUMBER(S)

12. DISTRIBUTION/AVAILABILITY STATEMENT
Approved for public release, distribution unlimited

13. SUPPLEMENTARY NOTES
See also ADM001736, Proceedings for the Army Science Conference (24th) Held on 29 November - 2 December 2005 in Orlando, Florida.

14. ABSTRACT

15. SUBJECT TERMS

16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
a. REPORT	b. ABSTRACT	c. THIS PAGE			
unclassified	**unclassified**	**unclassified**	**UU**	**2**	

Standard Form 298 (Rev. 8-98)
Prescribed by ANSI Std Z39-18

(5) Teleoperation of robotic vehicles from a moving platform and methods of mitigating motion sensory mismatch effects on the operator
(6) Methods of control for multiple robotic assets including mobility, surveillance, and targeting tasks
(7) Use of three-dimensionally audio effects and speech recognition technologies towards enhancing system control
(8) Methods of various levels of adaptive automation towards control of robotic platforms.

Through the use of a high-resolution, controlled, laboratory environment that is unrestricted by typical computational resources or platform hardware restrictions, the experimental capability described in this paper provides FCS system designers with the ability to explore design concepts and estimate the operational utility of the system design through the linkage of engineering models and operational simulations.